DOI: 10.17725/rensit.2023.15.463

Vladimir I. Vernadsky and the new paradigm

Gennady V. Mishinsky
Joint Institute for Nuclear Research, http://www.jinr.ru/
Dubna 141980, Moscow Region, Russian Federation
E-mail: mysh@jinr.ru

Received October 09, 2023, peer-reviewed October 16, 2023, accepted October 23, 2023, published December 06, 2023.

Abstract: **The main directions of V.I. Vernadsky's scientific activity during the period of the scientific revolution occurred at the end of the 19th and until the middle of the20th centuries are briefly listed. His decisive contribution to the initial research and practical application of the phenomenon of radioactivity and nuclear physics is shown. Based on the discovery of low-energy nuclear reactions more than 30 years ago, the development of Vernadsky's ideas about the role of radioactivity − the transformation of some chemical elements into other chemical elements − in geology, in the thermal balance of the Earth, in the prevalence of trace chemical elements is presented. Main provisions of the theory of low-energy nuclear reactions in condensed matter are listed: the threshold for excitation of the medium is indicated; shown is the possibility of generating a strong magnetic field in a unidirectional flow of electrons in a quasineutral plasma with the pairing of free electrons, and, subsequently, the pairing of atomic electrons into orthobosons with the latter forming a Bose-Einstein condensate, in which a new state of matter is formed − transatoms, which are combined, due to their ultra-strong magnetic fields, into nuclear transmolecule, in which multinuclear transmutation reactions occur with non-radioactive products; with the transformation of transmolecules into different sets of stable nuclei, subject to all conservation laws. In this case, the collective parameter that characterizes the quasi-equilibrium distribution of the mass numbers of isotopes – reaction products – is the "thermodynamic" coefficient of the energy content of the medium. Natural nucleosynthesis in the era of recombination of the Universe, which gave rise to the formation and development of organic chemical, and subsequently biochemical synthesis, is described. The development of Vernadsky's doctrine of the biosphere and noosphere of the Earth is supplemented by the concept of fractality of material, including biological structures with the further evolution of living matter, as well as by the concept of planetary nucleosynthesis. Starting from the idea of planetary nucleosynthesis, based on the mechanism of multinuclear quantum transitions of some atomic nuclei to others, a new doctrine of the geological development of the Earth and the foundations of quantum planetology were formulated, which explained the strict temporal cyclicity observed in the geological activity of the Earth associated with galactic jet energy flows. The issues discussed may become a basis for those directions in scientific research that will form a new paradigm, a new worldview.**

Keywords: **Vladimir I. Vernadsky, paradigm, low-energy nuclear reactions, nucleosynthesis, fractals, living matter, biosphere, noosphere, philosophy of science**

PACS: 01.70.+w; 03.75.Mn; 25.60.Pj; 25.70.Hi; 52.25.Xz; 91.35.Nm; 96.12.je; 98.70.Sa

For citation: Gennady V. Mishinsky. Vladimir I. Vernadsky and the new paradigm. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2023, 15(4):463-482e. DOI: 10.17725/rensit.2023.15.463.

Contents

1. INTRODUCTION

1.1. V.I. Vernadsky and his activities

On February 28, 2023 have passed 160 years since the birth of the outstanding Russian and Soviet scientist, academician Vladimir Ivanovich Vernadsky (1863-1945) [1]. That date not only reminded us of the role of V.I. Vernadsky in the development of science in the first half of the last century, but also stimulated us to turn again to his scientific heritage, including rereading his, according to Vernadsky himself, "main" book – "Chemical structure of the Earth's biosphere and of its environment" [2].

The range of Vernadsky's scientific interests was incredibly wide. His legacy contains works on geology, mineralogy, crystallography, and analytical chemistry. He studied soil science, biology, radiology, paleontology, and meteorology. His work made a huge contribution to the development of geochemistry. Vernadsky founded a new science – biogeochemistry. Vernadsky knew the history and philosophy of science well. He laid the foundations for the study of the noosphere known as a new period in the development of the biosphere.

V.I. Vernadsky was one of the first who appreciated the discovery of the phenomenon of radioactivity in 1896, who understood the power hidden in the atomic nucleus [3]. Having studied the works of A. Becquerel, W.C. Roentgen, M. Sklodovskaya-Curie, E. Rutherford and F. Soddy, Vernadsky came to the conclusion that the study of radioactivity and "uranium issues" could open new horizons in the development of mankind. Back in the fall of 1908, three years before Rutherford's discovery of the atomic nucleus, he gave a report on radioactivity research at the Department of Physical and Mathematical Sciences of the Academy of Sciences. The following year, he organized a radium expedition to Fergana, and subsequently compiled a review of deposits of radioactive minerals. 1911, V.I. Vernadsky organized in Saint-Petersburg the Mineralogical Laboratory, in which a radiological research department was created in 1914. On the basis of this department in 1915, the Radiological Laboratory was formed, which became the first scientific center in Russia for the study of radioactivity, and later, of the atomic nucleus.

1922, the Radiological Laboratory was transformed into the State Radium Institute, V.I. Vernadsky was appointed the first director of the Institute. The State Radium Institute consisted, at that time, of three departments: chemical department (in the future – department of radiochemistry), which was headed by V.G. Khlopin; physical department (nuclear physics), led by L.V. Mysovsky, and the mineralogical and geochemical department (radiology), which was headed by V.I. Vernadsky. Such outstanding scientists as academicians A.I. Alikhanov, A.P. Vinogradov, P.I. Kapitsa, I.V. Kurchatov, B.P. Nikolsky, A.E. Fersman, V.G. Khlopin, D.I. Shcherbakov; corresponding members of the Academy of Sciences V.V. Belousov, K.A. Nenadkevich, L.N. Bogoyavlensky, I.E. Starik; professors E.K. Gerling, L.V. Komlev and many other prominent specialists in the field of research and practical application of the phenomenon of radioactivity and nuclear physics worked at the Institute.

V.I. Vernadsky wrote in the same 1922: "... we are approaching a great revolution in the life of mankind that cannot be compared with anything it has previously experienced. The time is not far away when a man gets his hands on atomic energy, a source of power that gives him a capability to build his life as he wants. Will a man be able to use this power, direct it to good, and not to self-destruction?" [4]. This prophecy was made by V.I. Vernadsky 16 years before the discovery, in 1938, of uranium fission by thermal neutrons by German scientists O. Hahn and F. Strassmann.

It clearly follows from all of the above that V.I. Vernadsky can fully be considered the founder of nuclear research in Russia and in the Soviet Union.

Vernadsky was confident that the phenomenon of radioactivity, as the transformation of some chemical elements into other chemical elements accompanied by the release of enormous energy, would help to solve problems related to nuclear energy, geochronology, the thermal balance of the Earth, the state of trace chemical elements and related features of their migration and concentration in the earth's crust.

1.2. Modern development of V.I. Vernadsky's heritage

Our attention to the works of V.I. Vernadsky is associated, first of all, with the discovery of low-energy nuclear reactions (LENR) in 1989-1992 [5-8]. This discovery made it possible to formulate a new, Natural mechanism for the synthesis of chemical elements in the Universe [9] and, thereby, to try to answer many questions formulated by V.I. Vernadsky in the course of his investigation of the Earth's biosphere and its environment.

By Natural nucleosynthesis in the Universe we mean the transformation of some stable chemical elements into other stable chemical elements in low-energy nuclear reactions (LENR). Natural nucleosynthesis is an alternative mechanism to the synthesis of chemical elements, both in stars, as a result of thermonuclear reactions that require temperatures of hundreds of millions degrees, and to the synthesis of elements through the sequential capture of neutrons by atomic nuclei in the *s*- and *r*-processes with further beta decay of the nuclei. Nucleosynthesis in *r*-processes occurs at the stage of star death: at explosions of supernovae and neutron stars.

Low-energy nuclear reactions are divided into two types: cold nuclear fusion (CF) reactions and low-energy transmutation reactions of chemical elements (LET or transmutation).

Cold fusion reactions include reactions that involve hydrogen or deuterium, namely: protons or deuterons, and nuclei of the main element, for example: palladium, nickel, titanium. These reactions can occur spontaneously, without external influence. In solids, they occur preferentially in samples that have a size of the order of several nanometers. This sample size makes it possible to create a concentration of 2-3 hydrogen or deuterium atoms per one atom of the main element. CF reactions can also occur in solutions and melts. For the first time, the implementation of cold nuclear fusion reactions at room temperature was announced by M. Fleischmann and S. Pons in 1989 [10]. They realized the cold nuclear fusion reaction by electrolysis of a solution of deuterated lithium hydroxide in heavy water with a palladium cathode (0.1M LiOD in a solution of 99.5% D_2O + 0.5% H_2O).

Transmutation reactions occur for all chemical elements, starting with hydrogen, and occur, as a rule, with a simultaneous participation of a large number of atomic nuclei. LET reactions include both nuclear fusion and decay [18]. They occur in weakly excited condensed matter with an excitation energy in the reaction range of ~ 1 eV/atom. In ordinary nuclear reactions, in order to bring atomic nuclei closer to the distance of action of nuclear forces, it is necessary to overcome the Coulomb barrier that exists between them, which has values from tens of keV to hundreds of MeV. Transmutation reactions occur only as a result of external influences. Transmutation reactions predominantly occur in melts, solutions and dense gases, i.e. on free atoms and molecules. It is noteworthy that the products of transmutation reactions – isotopes of chemical elements – are non-radioactive.

Transmutation reactions were discovered in 1992 by A.B. Karabut, Y.R. Kucherov and I.B. Savvatimova in experiments on stimulation of cold nuclear fusion reactions in the method with a glowing gas discharge in deuterium with a palladium cathode [11]. Subsequently, transmutation reactions were discovered and reproduced many times in other numerous and varied experiments. For example, in a glowing gas

discharge [11-13]; at industrial, electronic, zone melting of zirconium ingots in a vacuum furnace [14]; at explosions of metal targets irradiated with a powerful electron pulse [15,16]; at explosions in liquid dielectric media of metal foils through which a powerful pulse of electric current was passed [17,18]; when exposed to a pulsed current on a lead-copper melt [19]; at the passage of electric current in water-mineral media [20]; at ultrasonic treatment of aqueous salt solutions [7]; when irradiated with braking gamma rays of condensed gases [21-23]; in growing biological structures [24-26] and in many others [1-3]. From the above list of transmutation experiments it is clear that their methods are extremely diverse and fundamentally different from the methods of nuclear physics.

Low-energy nuclear reactions occur due to exchange and resonance interference exchange interactions [27].

The discovery of low-energy nuclear reactions in 1989-1992 marked the beginning of a paradigm shift in science or a new scientific revolution [28-30].

The scientific revolution that currently takes place allows us to take a fresh look at the teachings of V.I. Vernadsky about the Earth's biosphere, to confirm and develop his hypotheses and foreknowledge.

2. "THERMODYNAMIC" QUASI-EQUILIBRIUM DISTRIBUTION

One of the main properties of matter, the way of its existence, is continuous movement. The movement can be chaotic or directed. For the most part, we see directional movement of particles of matter everywhere.

The unidirectional, collective movement of free electrons in a quasi-neutral plasma creates a magnetic field $\mathbf{B}_\mu$ (**Fig. 1***b*). This magnetic field owes its origin to the magnetic moments of electrons $\boldsymbol{\mu}_e$, which, in a unidirectional flow, due to the helicity property of electrons $\mathbf{p}_e\uparrow\uparrow\boldsymbol{\mu}_e(\mathbf{s}_e\downarrow\uparrow\mathbf{p}_e)$, are parallel to each other,

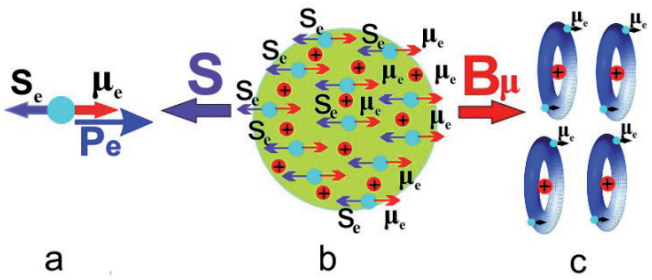

Fig. 1. *a – electron helicity, b – exchange* **S** *and magnetic* $\mathbf{B}_\mu$ *fields, c – orthobosons.*

where $\mathbf{p}_e$ is the momentum of the electron (Fig. 1*a,b*). At electron density $\rho > 10^{21}$ см$^{-3}$ (distance between electrons $< 10^{-7}$cm), the magnetic field $\mathbf{B}_\mu$ generates a Coulomb exchange field **S**, which is associated with the parallelism of electron spins $\mathbf{s}_e$ (Fig. 1*b*). In the Coulomb exchange field **S** in a quasi-neutral plasma, electrons are attracted to each other, which leads to the pairing of free electrons into orthobosons (Fig. 1*c*) [31].The Coulomb repulsion between electrons disappears in a quasi-neutral plasma with $\rho > 10^{21}$ cm^{-3}, due to the small Debye radius $r_D = 69(T/\rho)^{1/2} \sim 10^{-8}$ cm. The electron spins ($\mathbf{s}_e = 1\hbar/2$) are parallel in an orthoboson pair, and their total spin is equal to unity, $\mathbf{S}_{2e} = 1\hbar$. The pairing of electrons into an orthoboson is due to the appearance of a new quantum number in an electron in a strong magnetic field, generated by the oscillations of the electron around its orbital, and which did not manifest itself in any way in the absence of a magnetic field. The magnetic moments of the electrons $\boldsymbol{\mu}_e$ in the orthoboson are also parallel, and they create a strong magnetic field $\mathbf{B}_{2e} > 30$ *T* (**Fig. 2***a*).

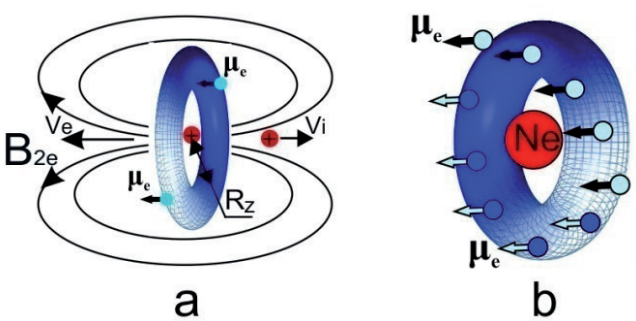

Fig. 2. *a – orthoboson, b – Neon transatom.*

Atoms turn into transatoms in magnetic fields >30 *T*. In a transatom, its orbital electrons are also pairwise bound into orthobosons [32]. Atomic electron orthobosones merge into a Bose-Einstein condensate, in which all electron spins and, accordingly, their magnetic moments are parallel to each other (Fig. 2*b*). The magnetic moments of electrons generate ultra-strong magnetic fields up to $\mathbf{B}_S \sim 10^5$-10^{10} T inside and around transatoms [33].

This mechanism explains the existence of strong and superstrong magnetic fields in cosmic plasma.

The internal ultra-strong magnetic field interacts with the magnetic spin and magnetic orbital moments of the nucleons in the nucleus, changes the structure of the nucleus and turns it into a transnucleus. Nucleons in the transnucleus: pairs of protons and neutrons (fermions with spin equal to s = 1ħ/2), also form orthobosons with $S_{2p,2n}$ = 1ħ, but they are already nuclear orthobosons. The transnucleus with surrounding electron orthoboson Bose-Einstein condensate forms a new state of matter – a spin nuclide electron condensate [33,34].

External ultra-strong magnetic fields of transatoms connect their electron Bose condensates into one, common electron condensate. And their nuclei form a nuclear transmolecule, in which multinuclear transmutation reactions occur [27,35] (**Fig. 3,4**). Transmutation reactions can occur with the participation of electron orthobosons. Thus, strong and weak interactions occur simultaneously in transmutation reactions. Therefore, the products of nuclear transmutation reactions are non-radioactive. These reactions release nuclear energy. The reaction products scatter in different directions. And if the atoms of the reaction products are not in a strong magnetic field, then they become ordinary atoms with ordinary nuclei. As a result of transmutation reactions, the nuclear transmolecule is transformed with the appropriate probability into different sets of stable nuclei, subject to conservation laws: energy, electric, baryon and lepton charges conservation, etc. **Fig. 4** shows a diagram of eight of the twenty-two possible transitions of an aluminum transmolecule, that consists of transatoms of helium, boron and carbon, into two or three stable nuclei. Multinuclear reactions can be considered as a simultaneous, multinucleon exchange between transnuclei that make up a transmolecule [36].

The energy is released during transmutation due to the positive difference between the sums of the masses of the initial and newly formed nuclei, taking into account the binding energy of their electron shells. This difference arises due to different binding energies of nucleons in nuclei (nuclei mass defect) (**Fig. 5**). Transmutation reactions that continuously occur in a condensed matter lead to a quasi-equilibrium distribution of isotopes – reaction products – by mass numbers.

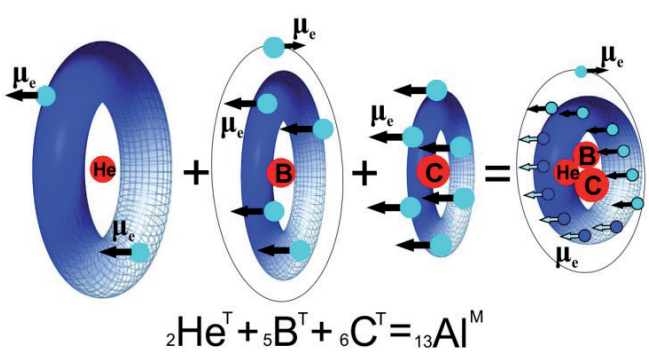

Fig. 3. *Formation of aluminum transmolecules from helium, boron and carbon transatoms.*

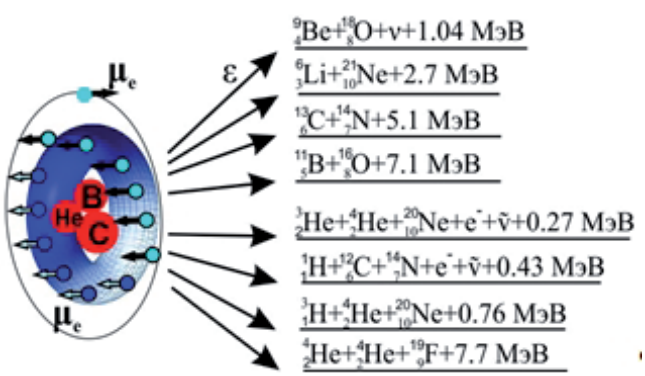

Fig. 4. *Scheme of transitions of an aluminum transmolecule into two or three stable nuclei.*

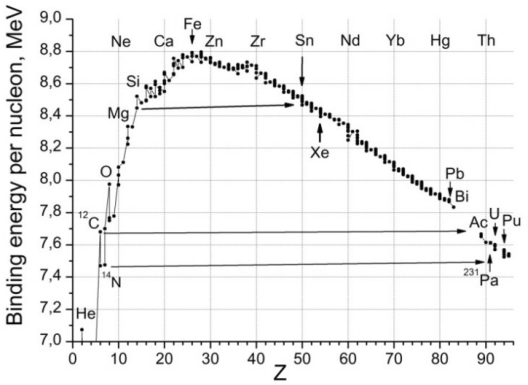

Fig. 5. *Coupling energy per nucleon in stable atomic nuclei.*

The laws of statistical physics can be applied to transmutation processes on the basis that transmutation can be represented not as an exchange of energy between particles, but as an exchange of nucleon portions between nuclides ($E = mc^2$). As a statistical ensemble, we can use all types of sets of a limited number of 286 stable nuclides.

In statistical physics, the energy distribution E for colliding gas atoms at temperature T is described by the Maxwell distribution:

$$f_E = \frac{2\pi}{\sqrt{(\pi kT)^3}}\sqrt{E}\exp(-E/kT).$$

For transmutation processes, we replace the energy in the Maxwell distribution with the masses of isotopes M_A or with the mass numbers of isotopes A: $E \to A$, and kT with the energy content coefficient of the medium G, which characterize the transmutation process: $kT \to 2G$:

$$f_A = \frac{C}{\sqrt{(2G)^3}}\sqrt{A}\exp(-A/2G), \quad (1)$$

where C is the normalization coefficient. Just as the temperature of a system T is a collective parameter of its constituent particles, so the number G determines the collective energy content of the medium [37]. The energy content coefficient of a medium depends on the total binding energy of its constituent nuclei (Fig. 5). The lower the total binding energy of all nuclei, the greater the energy content of the medium, the greater the coefficient G. It is noteworthy that the energy content of systems that consist of atoms, for example: carbon-nitrogen and thorium-uranium, is approximately the same (Fig. 5). The energy content coefficient has a maximum value in a medium that consists of hydrogen atoms, whose binding energy is zero. Transmutation reactions do not occur in a medium made up exclusively from iron and nickel isotopes with the maximum binding energy per nucleon: ^{56}Fe-8.790 MeV, ^{58}Fe-8.792 MeV and ^{62}Ni-8.794 MeV (Fig. 5). The mass number of A varies from 1 to 250, from hydrogen to californium-250 isotope in the "thermodynamic" distributions corresponding to formula (1) (**Fig. 6**). Energy content coefficient G in Fig. 6 has three, arbitrarily chosen, values G = 8, 12 and 24. These values correspond in the distributions to the maximum values of the mass number Amax, which determines the physical meaning of the coefficient $G = A_{max}$. Since transmutation reactions occur with a loss of internal energy of the atomic nuclei of the medium, the energy content coefficient G will constantly decrease during the transmutation process.

Thus, the resulting distribution, firstly, will be quasi-equilibrium distribution; secondly, all chemical elements, including heavy and superheavy ones, will be synthesized at high

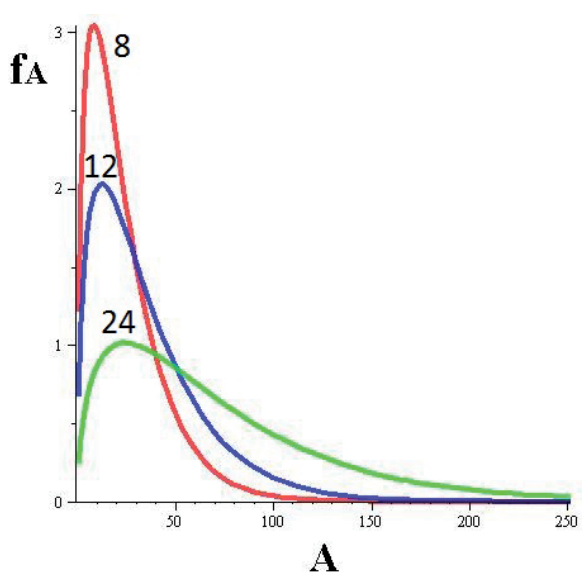

Fig. 6. *"Thermodynamic" mass number distributions A for transmutation processes.*

values of the energy content coefficient G, thirdly, as the coefficient G decreases, the distribution, conditionally, will change from the distribution described by the line with $A_{max} = 24$ in Fig. 6, to the distribution described by the line with $A_{max} = 8$. Consequently, chemical elements with small and medium mass numbers will be mainly synthesized. And heavy and superheavy elements will be transformed into lighter elements; fourthly, the presence of iron and nickel, that do not participate in transmutation reactions, will increase in the distribution over time. By the content of these elements in an object, by its mass density, one can judge the duration of the transmutation processes that occur in this object.

Consequently, quasi-equilibrium distributions reflect the occurrence of chemical elements and their isotopes in different objects and regions of the Universe.

Vernadsky V.I. wrote in the book [2]: "It turned out that the quantitative atomic composition of the Earth's crust is not a random phenomenon. It is closely related to the diverse properties of atoms in the physical, primarily thermodynamic, field to which the Earth's crust responds. The Earth's crust in the Phillips-Clark-Focht table (a table of concentrations of chemical elements) quantitatively corresponds to some important *planetary manifestation of atoms*. As a result of astrophysical research, it turned out that the surface layers of stars, including the Sun, reflect, approximately, the same quantitative atomic composition, which is expressed in the P-C-F table. …There can hardly be any doubt that as geological processes are deeply studied, their not only terrestrial, but planetary character will be revealed with ever increasing sharpness".

3. NUCLEOSYNTHESIS. LIVING MATTER

Since the transformation of chemical elements in transmutation reactions occurs at low excitation energies of condensed matter ~ 1 eV/atom, natural nucleosynthesis started in the Universe during the Recombination Era approximately 50 thousand years after the Big Bang (BB). At the same time, matter began to dominate over electromagnetic radiation, "light was separated from darkness", which led to a change in the expansion regime of the Universe. The Recombination Era began approximately 18 thousand years after BB, when electrons began to combine with helium nuclei to form He^+ ions. At that time, matter consisted mainly of electrons, protons, deuterons (0.5% of nuclei) and helium nuclei (6% of nuclei).The beginning of nucleosynthesis is associated with two circumstances: firstly, directed electromagnetic radiation that comes from the hot center of the Universe generated directed flows of free electrons, which create strong magnetic fields. And, secondly, 50 thousand years after the BB, there was already a sufficient number of neutral helium atoms in the cosmic plasma, which were the first to participate in transmutation reactions [38]. It is noteworthy that the isomer of the helium atom, namely, orthohelium, is the only one of all atoms of chemical elements, which, due to the parallelism of the magnetic moments of the electrons, has a strong magnetic field of ~ 70 T at the radius of the atom. This property of orthohelium radically increases the intensity of nucleosynthesis processes [21,38]. Due to the strong magnetic field, orthohelium atoms are attracted to each other and form helium transatoms (Fig. 3). Helium transatoms, which combine due to an ultra-strong magnetic field, form multinuclear molecules. The creation of such transmolecules leads to multinuclear transmutation reactions, with the emission of protons, neutrons, alpha particles and the formation of heavy chemical elements with a nuclear charge $Z \geq 6$ (**Fig. 8**).

100 thousand years later, electrons recombined with all the helium nuclei to form neutral helium atoms and with half of the protons to form hydrogen atoms. The temperature of the cosmic plasma at that time was ~ 4000 K or ~ 0.4 eV. The Recombination

Era ended 380,000 years after the Big Bang with the neutralization of all hydrogen atoms. It can be assumed that nucleosynthesis due to transmutation reactions did not stop with the end of the Recombination Era, but continued due to the always available hydrogen and helium atoms and energy flows that comes from the center of the Universe and creates cosmic plasma.

As a result of transmutation reactions, the onset of nucleosynthesis led to the appearance, first of all, of light chemical elements in cosmic hydrogen-helium plasma: carbon, nitrogen and oxygen, the atomic content of which was more than two orders of magnitude higher than the production of other chemical elements (**Fig. 7, 8**) [21,22,39]. It is obvious that the appearance of carbon *C*, nitrogen *N* and oxygen *O*, when they are overwhelmingly surrounded by

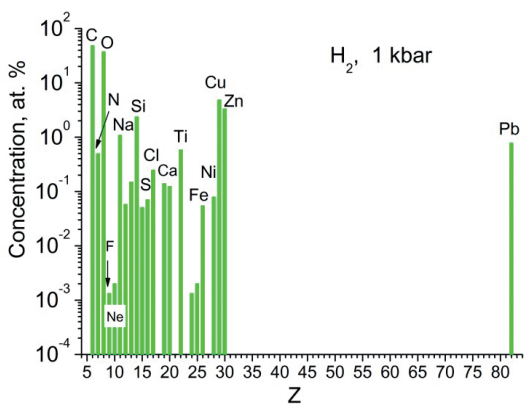

Fig. 7. *The average concentrations of chemical elements over 15 measurements of different objects.*

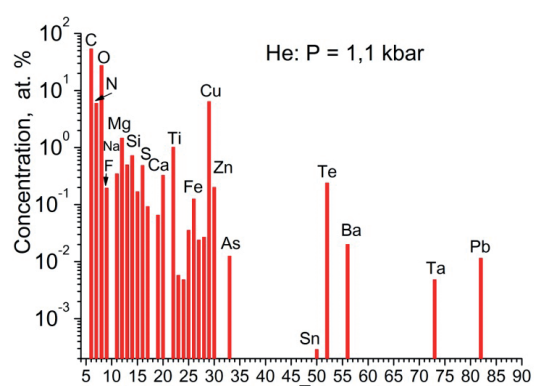

Fig. 8. *The average concentrations of chemical elements over 11 measurements in an experiment with He at P=1.1 kbar.*

hydrogen ions H^+ and its *H* atoms, immediately leads to the launch of organic world reactions with the production of molecules: methane CH_4 and other hydrocarbons, including those that contain *C = O* and *COOH* groups, ammonia NH_3, cyanide *HCN*, water H_2O, carbon dioxide CO_2, etc. Hydrogen, carbon, nitrogen and oxygen are the basic elements in diverse organic world.

Thus, the nucleosynthesis that began simultaneously gave rise to the processes of inorganic chemistry, but, to a greater extent, organic chemistry, and, ultimately, the parallel formation and development of Inert matter and Living matter. Organic matter after nucleosynthesis during the Recombination Era many times prevailed over inorganic matter (excluding hydrogen and helium). The subsequent transition of organic matter into inorganic matter is associated with the destructive action of the external environment and transmutation reactions that occur in condensed matter.

Figures 7 and 8 show the results of experiments performed by A.Yu. Didyk and R. Wiśniewski on the synthesis of chemical elements during irradiation of condensed gases hydrogen and helium with braking gamma rays with a boundary energy of 10 MeV [21-23,39]. A unidirectional flow of braking gamma quanta creates a unidirectional flow of free electrons, which generate strong magnetic fields, Fig. 1*b*. The orthohelium atom itself has a strong magnetic field [38]. Atoms are transformed into transatoms in strong magnetic fields, and transmutation reactions induce nucleosynthesis. In addition, after the end of irradiation, newly created objects were discovered in the reaction chambers in all experiments: particles and other simple and complex microstructures.

Eight particles with sizes of ~ 1 mm were discovered in the reaction chamber in an experiment with hydrogen at a pressure of *P* = 1 kbar. A photo of one of these particles measuring ~700×630 μm is shown in **Fig. 9***a*.

a *b*

Fig. 9. *Particles synthesized in experiments with hydrogen at pressures: a – P = 1 kbar; b – P = 3.4 kbar.*

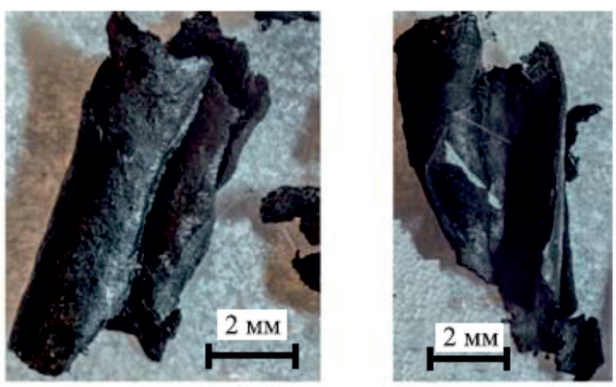

Fig. 10. *Photo of graphite foils.*

One black particle was found in the chamber in another experiment with a pressure of P = 3.4 kbar (Fig. 9*b*). The particles consisted primarily of carbon and oxygen.

Thin, cylindrical, black foils of considerable size were discovered in the inner part of the reaction chamber in an experiment with helium at a pressure of 1.1 kbar. The foils (**Fig. 10**) contained mainly carbon and oxygen and left an oily residue on the paper. The latter indicates the presence of liquid oils in the form of hydrocarbons on the foils and the synthesis of hydrogen.

It follows from the experiments presented above and numerous other experiments that a synthesis of not only new chemical elements, but also the synthesis of extraneous solid structures that contains these new elements occurs in the process of transmutation.

There are several mechanisms for the formation of solid structures in condensed matter. This is, first of all, the chemical combination of particles, the formation of structures as a result of resonant interference exchange interaction between different objects and the formation of structures due to the fractal geometry of nature.

One of the fundamental properties of objects is that they all have wave properties described by de Broglie waves λ. This property is of fundamental importance, since without it the following would be impossible: exchange interaction between identical objects and resonant interference exchange interaction between objects that have common resonant states [27]. For a particle, the de Broglie wavelength is $\lambda = h/mV$, where h is Planck's constant, mV is the momentum of the particle: the product of its mass m and velocity V. A hydrogen atom with a mass of 1 amu at room temperature 300K has the de Broglie wavelength λ_H = 0.145 nm (the diameter of the hydrogen atom is 0.106 nm). The lower the velocity V of a particle, the longer the de Broglie wavelength λ, the greater the distance it interacts with other identical particles in an exchange manner.

3.1. "Boson body"

Boson particles tend to occupy one state, and thereby to form a Bose-Einstein condensate. Consequently, boson atoms and boson molecules can concentrate in one place and form a "boson body". The thermal speed of the "boson body" decreases with an increase in the mass of the "boson body" and its crystallization, when bosons bind. From thermodynamics $V = \sqrt{\frac{3kT}{N \cdot m}}\left(\frac{3}{2}kT = \frac{N \cdot m \cdot V^2}{2}\right)$, where k is Boltzmann's constant, T is temperature, N is the number of identical bosons of mass m in the "boson body". Consequently, the "boson body" reduces the speed of bosons by a factor $1/\sqrt{N}$ and increases the de Broglie wavelength $\lambda = \frac{h}{mV} = h\sqrt{\frac{N}{3kT \cdot m}}$ by a factor $\sqrt{N}$. The force that attracts other identical bosons is proportional to the number of bosons N that make up the "boson body". Let us remember that one mole contains $6 \cdot 10^{23}$ particles. For this reason, the "boson body"

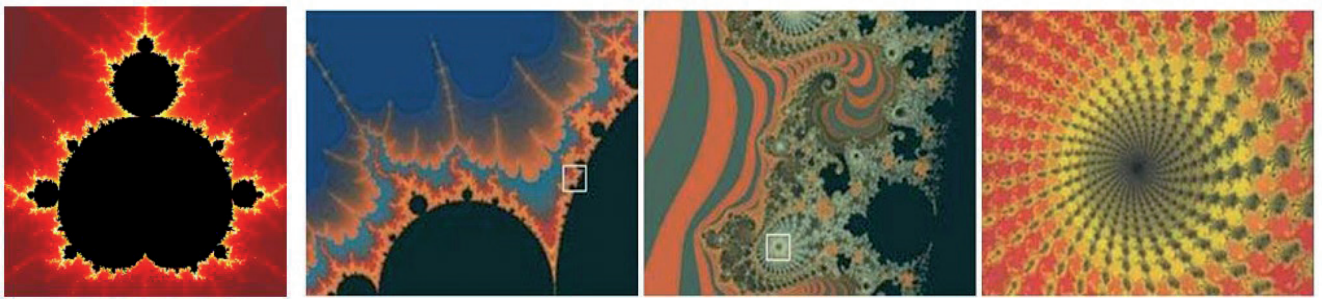

Fig. 11. *Mandelbrot set.*

constantly increases its size due to the addition of identical bosons to itself.

In a "boson body" that consists mainly of hydrogen, carbon, nitrogen and oxygen, intense reactions, including organic chemical reactions, begin under the influence of electromagnetic radiation and other external influences. Organic chemical synthesis leads to the formation of a variety of organic molecules, and, subsequently, biochemical molecules. Thus, recently a group of scientists identified chemical reactions that could lead to the emergence of life [40]. These chemical reactions occur with the participation of only four chemical elements that represent the inert matter: keto acids (hydrocarbon derivatives that contain $C = O$ and $COOH$ groups), cyanide HCN, ammonia NH_3 and carbon dioxide CO_2, and the products are: amino acids and nucleic acids, which are the building blocks for proteins and DNA of Living matter.

3.2. Fractals

All matter consists of a multitude of both diverse and similar identical systems. In turn, any system consists of its constituent connected objects. The same objects can be in a free state in the space that surround the system.

One of the main properties of systems is the ability to form other, self-similar systems within themselves or from free objects that surround them. "If each of the parts of a certain form is geometrically similar to the whole, then this form and the cascade that generates it are called self-similar structures" (Mandelbrot, [41]).

This property of systems is called *Fractal geometry of nature* [41]. This geometry describes both mathematical space and, what is fundamentally important, the physical Universe (**Fig. 11, 12**). Fig. 11 shows the Mandelbrot set, which is a classic example of an algebraic fractal. Three successive enlargements of fragments (marked with squares) shown in Fig. 11 allow us to see similar, repeating structures of the Mandelbrot set with the addition of many new and previously non-repeating elements. The Mandelbrot set reflects the self-similarity that forms a basis for infinite diversity!

Building fractals in physical space is one of main properties of the Matter that makes up any Structures.

Fractal geometry is inherent in all material structures, from atomic nuclei to stars and galaxies. Even the characteristics that describe Chaos are subject to the law of fractal geometry [42]. We should go further and see that Intellectual images, constructions and structures associated with Consciousness and Mental activity in the field of art, humanities, social and political sciences also obey the laws of fractal

Fig. 12. *Fractals of mountains, clouds, rivers and Living matter.*

self-similarity. This property is especially evident in music and architecture.

Fractals are created by both Inert matter and biological, Living matter. Thus, Inert matter and Living matter reproduce themselves, i.e. MULTIPLY. Biological organisms proliferate particularly intensively. Living matter are biological structures and organisms capable of self-similarity and reproduction due to the processing of inert matter, consisting of organic and inorganic molecules and structures. Living matter differs from Living substance, which Vernadsky defined as follows: "I will call Living substance the totality of organisms that participate in geochemical processes. The organisms that make up the totality will be elements of Living substance" [43].

It is noteworthy that large structures that are capable of creating more stable substructures within themselves can "spontaneously" disintegrate into them. This property of systems is also reproduction. It is characteristic of nuclei: cell nuclei and nuclei of transuranium chemical elements. In politics, this phenomenon is observed during the collapse of empires. Probably, the decay phenomenon is also characteristic of the nuclei of some planets.

The condensed substance changes its internal state and internal structure under the influence of external environmental factors. Inert matter in strong magnetic fields is transformed through transMutations of chemical elements, and the development of Living matter occurs due to Mutations in its biochemical structures.

The difference between transmutations and mutations is determined by the energy of these processes and, as a consequence, their intensity. To transform Inert matter, it is necessary to exert a strong action on it, and a weak action is sufficient for the transformation of Living substance. Therefore, Living matter evolves through intensive mutations several orders of magnitude faster than Inert matter.

Thus, from the very beginning of nucleosynthesis, the development of Inert matter and the evolution of Living matter were always going and are going in parallel and interpenetrating each other. Since they consist of identical atoms, Living matter grows due to the processing of Inert matter, and Inert matter is replenished at the expense of Living matter after its death.

In the Universe, "boson bodies" began, starting from the Recombination Era to form, first of all, from light chemical elements, from which organic and biological planets were later formed. Thanks to mutations and the fractal geometry of nature, primitive organic life must first have appeared, and subsequently intelligent life must have developed on these organic planets [44]. It is difficult to imagine the capabilities of a Supreme Intelligence aged more than 12 billion years.

From the above, two important statements can be made:

- Life is eternal in a physically eternal Universe.
- The Universe is filled with Living matter.

V.I. Vernadsky wrote: "The spreading of life, expressed in the omnipresence of life, is a manifestation of its internal energy" [1]. These statements are consistent with three points made by V.I. Vernadsky, who believed that, firstly, "life is eternal insofar as the cosmos is eternal" [45], and secondly, "living things are generated only by living things." And, therefore, thirdly, "only cosmos is the source of terrestrial life". Vernadsky opposed mechanical theories of the spontaneous generation of life on Earth through the arbitrary transformation of inorganic matter into organic and biotic. "Life, eternal in the Universe, appeared New on Earth. The germs of Life were constantly brought into it from the outside, but they strengthened on Earth only when there were favorable opportunities for this on Earth" [45]. This statement, a confirmation by V.I. Vernadsky, we consider to be valid for any object in the Universe.

4. PLANETARY NUCLEOSYNTHESIS AND GALACTIC JET STREAMS OF MATTER AND ENERGY. LIVING EARTH

The first stars and galaxies began to form after ~0.5 billion years of development of the Universe. At this stage, when the density of matter and the directional movement of free electrons reached values sufficient for the generation of magnetic fields and the pairing of electrons in them, low-energy transmutation reactions of chemical elements similar to those that had been taking place since Recombination Era began again.

And again, first of all, light chemical elements were synthesized from hydrogen and helium: carbon, nitrogen and oxygen. These chemical elements that created a cosmic, condensed environment, were a fertile "soil" for the "embryos of life" − Living matter, the entire cosmos of which by that time was already contaminated. Therefore, the formation of the Earth and the formation of its Biosphere occurred simultaneously from the very beginning. "For our planet, the existence of life in the most ancient sediments accessible to us, known to us on our planet, has been empirically established. On the other hand, we have not found rocks anywhere in the biosphere that would indicate their formation over geological time in the absence of living substance. …The biosphere is geologically eternal", − wrote V.I. Vernadsky – "If the amount of living substance is lost on the background of inert and bioinert masses of the biosphere, then biogenic rocks (i.e. created by living substance) make up a huge part of its mass, and go far beyond the biosphere. Taking into account the phenomena of metamorphism, they transform, losing all traces of life, into a granite shell and leave the biosphere. The granite shell of the Earth is the region of former biospheres" [2].

Since the transformation of chemical elements in low-energy transmutation reactions occurs under fairly "soft" physical conditions of ~ 1 eV/atom and reproduces a quasi-equilibrium distribution, it can be concluded that the process of nucleosynthesis carries out on planets and shapes their elemental composition [8,46-49]. Now, in the Earth's magma, transmutation processes continue, and the colossal energy released during this process is observed by us in the constant movement of lithospheric plates and in volcanic eruptions. Experts know that intraplate tectonic activity and volcanism cannot be explained within the framework of plate tectonics. The most common hypothesis that satisfactorily explains volcanism and tectonic activity within both the oceanic and continental lithosphere is associated with the ideas of hot spots and mantle plumes [50]. Apparently, it is in these hot spots and mantle plumes that transmutation processes occur.

V.I. Vernadsky wrote: "Everything indicates that the radioactive decay of chemical elements − the transformation of one isotope into another − is not a special case, but a general property of terrestrial matter. All chemical elements of the Earth are in the state of radioactive decay. This is the basic physical and chemical process, which is the root cause of all geological phenomena. The chemical degeneration of the planet is, in the end, its consequence... It is characteristic of trace elements, at least for their main mass, that the regularities of their distribution cannot be explained by chemical processes. They are continuously created and transformed into new isotopes of other elements throughout the matter of our planet. The phenomenon of trace elements − a large terrestrial exothermic process − introduces probably more heat into our planet than the "spontaneous" decay of radioactive atoms" [2].

Judging from the idea of planetary nucleosynthesis, based on the mechanism of multinuclear quantum transitions of one atomic nuclei to another, we have formulated a new doctrine of the geological development of the Earth:

1. The geological development of the Earth is a monotonous, evolutionary process, which is superimposed by revolutionary, stepwise periods.

2. The evolutionary process is determined by internal energy sources: low-energy nuclear reactions, radioactive decays, gravitational compression, etc. Since the energy coming from internal sources monotonically decreases, geological processes monotonically slow down.

3. Abrupt, including cyclical periods in the development of the Earth are generated by external energy sources that stimulate geological activity on Earth. During these periods, geological processes accelerate, sometimes in revolutionary, explosive ways.

4. External energy sources are the Sun, jet streams of energy and matter from the Galaxy and outer cosmos. Perhaps there are other, external energy sources available. External energy sources can influence the Earth directly or indirectly through the Sun and the giant planets of the solar system.

V.I. Vernadsky emphasized in the book [2]: "We are in geology − in the history of planet Earth − are continuously, really confronted with the energetic and material manifestation of the Milky Way − in the form of cosmic matter − meteorites and dust and material-energetic, penetrating cosmic radiation invisible to the eye and not consciously perceived by humans. Cosmic rays come to us from the Galaxy continuously. I proceed from the scientific hypothesis that these rays, on their way, break up the atoms of most chemical elements, transform them into others, and constantly there is a synthesis of enormous released thermal energy, which should have great geological significance and which is still, taken as a whole, is not taken into account by geologists. ...Solar energy, which creates life on our planet, pales in its power on the background of the so-called cosmic penetrating radiation. We will see the geological significance of these radiations and their role in the thermal regime of the planet".

The idea of planetary nucleosynthesis led us to the creation of a new scientific discipline − Quantum planetology (geology) [47-49]. Within the framework of quantum geology and the new doctrine of geological development of the Earth, the strict temporal cyclicity observed in the geological activity of the Earth has been explained.

According to a study published in the journal Geoscience Frontiers [51], geological activity on Earth follows a well-traced cycle of approximately 27.5 million years. Previously, it was believed that geological events were random. But the analysis of geological events over the past 260 million years showed that, in fact, there is a strict cyclicity in geological activity. **Fig. 13** presents the results of an analysis of 89 geological events using a 10 million year sliding window centered every 0.5 million years. The number of events that fell into the sliding window was calculated at intervals of 1 million years. Ten peaks are clearly visible. This analysis was carried out thanks to significant improvements in radioisotope dating techniques and in methods for measuring time on the geological scale.

The fact of presence of cyclical fluctuations in the Earth's geological activity is a serious deviation from generally accepted views. However, the observed cyclicity fits perfectly into the above new doctrine of the geological development of the Earth. The galactic year

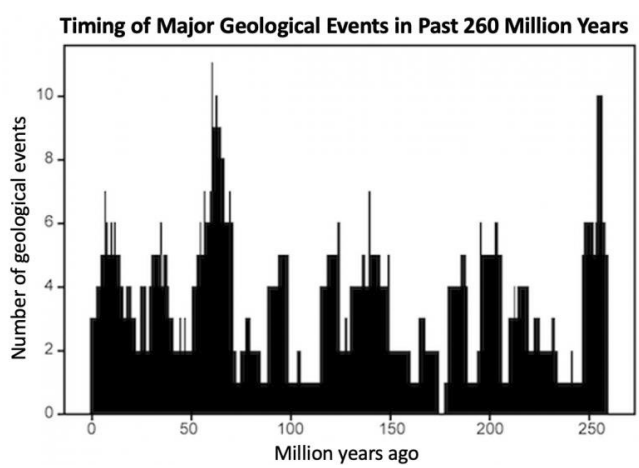

Fig. 13. *Cyclicity of the Earth's geological activity* [51].

amounts, according to various estimates, from 180 to 250 million years. The Sun and its planets are believed periodically, four times per galactic year, approximately every 60 million years, cross the visible jet streams of matter and energy ejected from the center of the Galaxy disk [19,52]. If the cycle of geological activity on Earth of 27.5 million years is associated with galactic energy flows, then we should assume the existence of four additional, invisible, jet energy flows located between the visible flows. Based on these considerations and on a cycle of 27.5 million years, the Galactic year will be equal to 220 million years.

In our opinion, jet energy streams (JES) of the Galaxy trigger transmutation reactions in stars and planets. The nuclear energy released in these reactions, colossal in scale, causes super-powerful activity of matter in the volumes of stars and planets. These phases of activity of the solar system (PASS), associated with the JESs of the Galaxy, lead to huge changes in the structure of the Sun and planets.

Scientists called the 27.5 million year cycle as the "pulse" of the Earth. It is obvious that the "pulse" of the Earth is set by the JESs – the rhythm of the energetic "heartbeat" of our Galaxy. An interesting challenge for planetary science and astronomy is to record the invisible, jet energy flows of the Galaxy by detecting their impact on stars and their planetary systems. If the JESs of the Galaxy are constant during the formation of the entire solar system, then since the formation of the Earth 4.54 billion years ago as an independent planet, it has been exposed to these flows 165 times.

If the explosive transmutations that regularly occur in the history of the Earth are equated to mutations in Living matter, then it can be argued that the geological shells of the Earth and the biosphere are constantly adapting to the impact of cosmic radiation. Thus, the geosphere and biosphere co-evolve and become more and more structurally and functionally interconnected with each other, ultimately becoming a Unified System. It is obvious that dramatic changes in one of these areas can lead to catastrophic changes in others. For this reason, planet Earth should be perceived as entirely Alive planet. "Throughout the entire period of geological phenomena, which we scientifically cover during the period of 2-3 billion years, we see the existence of life, the existence of the biosphere on the planet Earth" [2].

Due to the "shake-up" of the entire solar system every 27.5 million years, "lifeless" planets have a chance to restart their history with the possibility of the emergence of life, if there was no life on these planets or it disappeared.

In other cases, if vegetable life, animal life, and, especially, intelligent life in the form of highly developed civilizations existed on the planets, then during periods of destructive planetary activity, the vegetable and animal parts of the biosphere, if would not have disappeared, then had to be radically transformed. And highly developed civilizations were forced to leave their "living" planets and move to "dead" or artificially created planets on which transmutation reactions would be impossible. After the end of the activity phase of the solar system, highly developed civilizations could return to their home planets or put them under observation, if, for example, the conditions of existence of their civilization changed on them (the composition of the atmosphere, the temperature on the surface of the planet, etc.) or another life appeared with a changed structure, different from their genetic structure. Therefore, if we assume that highly developed civilizations in the intervals between the phases of activity of the solar system closest to our time existed on Earth, then during the period of geological activity of the Earth they had to leave it. And now they regularly visit our common planet, but not as Aliens, but as AlienEarthmen.

The last phase of solar system activity ended approximately 7 million years ago. This allows us to assume and hope that the peak intensity of the next catastrophic geological activity on Earth will occur in 20 million years. And, if the Humanity does not self-destruct themselves before that time, then in approximately 17 million years they will be forced to leave the Earth!

5. CONCLUSION

Nowadays, a paradigm shift in science occurs or in other words, a new scientific revolution takes place associated with the discovery of low-energy nuclear reactions and the discovery of fundamental resonant interference exchange interaction. The previous scientific revolution began in 1896 with the discovery, by A. Becquerel, of the natural radioactivity of uranium salts. This event was followed by the creation of quantum mechanics, atomic and nuclear physics, special and general relativity theories, and the discovery of electromagnetic, strong and weak interactions.

The whole scientific activity of V.I. Vernadsky took place during a paradigm shift. Vernadsky wrote: "We are currently experiencing a revolutionary movement in science that has nothing comparable; only the 17th century, with its victory of the ideas of Copernicus, with great discoveries of Kepler, Galileo, and Newton, may, perhaps, have a distant analogy with our time. Before the change in scientific thinking, which is taking place before our eyes steadily and at an increasingly rapid pace, surprisingly little noticeable to contemporaries, the entire 19th century with its scientific development will probably seem in the history of thought to be a mere preparation for the great revolutionary movement of the 20th century" [1]. Having made this conclusion, V.I. Vernadsky practically anticipated the discovery of the law of paradigm shift made by T.S. Kuhn in 1962 [28]. At the same time, Vernadsky pointed out that the formation of a new worldview is preceded by a stage of scientific research conducted within the framework of the old paradigm. After the integration period, which is the confirmation of a new worldview, the era of the most extensive, differential research in emerging, new scientific directions and disciplines begins again. It is obvious that the integral and differential periods of scientific research during the operation of the paradigm are its components.

With the discovery of low-energy nuclear transmutation reactions, we have proposed a new mechanism for the nucleosynthesis of chemical elements, which occurs both at the stage of formation of the very early Universe, and in stars and planets. Transmutation reactions occur with the participation of many atoms and many nuclei. This approach allowed us to take a new look at various processes that occur in the Universe.

Transmutation reactions that continuously occur in a condensed matter lead to a quasi-equilibrium distribution of isotopes − reaction products − by mass numbers. The collective parameter that characterizes the quasi-equilibrium distribution is the "thermodynamic" coefficient of energy content G of the matter. Quasi-equilibrium distributions reflect the occurrence of chemical elements and their isotopes in different objects and regions of the Universe.

The implementation of nucleosynthesis of chemical elements in the Recombination Era allowed us to understand that the development of Inert substance and the evolution of Living matter have always been going and are going in parallel and interpenetrate each other. Thus, Life revealed itself to be eternal in a physically eternal Universe. Since the evolution of Living matter was much more intense compared to the development of Inert substance, then it filled the entire early Universe, and formed the Seeds of Life for future planets in star systems.

The discovery of fractal geometry made it clear that the existence and evolution of the Universe occurs due to one of main

properties of structured Matter and intellectual forms of Consciousness − the ability to build fractals. Moreover, the fundamental law of the Development of matter and consciousness has been identified from this property of fractal geometry − The creation of self-similar structures and their reproduction is the basis of infinite Diversity!

Judging from the idea of planetary nucleosynthesis, based on the low-energy mechanism of multinuclear quantum transitions of one atomic nuclei to another, we created a new scientific discipline − Quantum planetology (geology) and formulated a new doctrine of the geological development of the Earth. The new doctrine allowed us to explain the cyclicity observed in the geological activity of the Earth, thereby suggesting the existence of visible and invisible jet energy flows coming from the center of our Galaxy. It is obvious that Galactic jet energy flows, that stimulate geological activity on Earth, determine the beginning and end of geological eras and periods in the evolution of the geosphere and biosphere of the Earth.

The geosphere and biosphere evolved together throughout the formation of the Earth and became more and more structurally and functionally interconnected with each other, and, eventually they have become a Single Living System − the Earth.

Vernadsky believed that the biosphere, due to ongoing scientific and technological progress, made the transition to the noosphere at the beginning of the 20th century. As main reasons for the emergence of the noosphere, V.I. Vernadsky indicated: human population of the entire planet; development of planetary communication systems and communications, creation of a unified information system; discovery of new energy sources such as nuclear energy; access to the management of states by the broad masses of people; predominance of the geological role of man over other geological processes that occur in the biosphere. V.I. Vernadsky pointed out in 1944 [2]: "In the twentieth century, a man recognized and embraced the entire biosphere for the first time in the history of the Earth. Humanity, taken as a whole, have become a powerful, ever growing geological force. The question of restructuring the biosphere in the interests of free-thinking humanity as a single whole arises before humanity, before their thought and work. This new state of the biosphere is exactly the noosphere".

In addition to the fact that Humanity have turned into a powerful geological force capable of destroying the biosphere and itself, due to publicly available means of communication, it has been transformed into a Single Whole with a single world production, with a world economy, with a world but diverse culture, with a world diverse art, with a world science, with a world history. V.I. Vernadsky wrote in 1912: "This has never happened before, and in vain we would look for analogies of the era of the 17th-20th centuries in the past of mankind. It is not without reason that this is recognized now, when before our eyes, world history is emerging more and more clearly and powerfully, and embraces, as a single whole, the entire globe, completely putting an end to the secluded cultural historical areas of the past, that little depend on each other" [53].

Vernadsky possessed a huge amount of knowledge, formed a new worldview, synthesized various directions in science, which had previously developed within the narrow framework of their specialization. Many of Vernadsky's studies were ahead of his time, and some ideas became prophetic and are only understood by us at the present time. The ideas of V.I. Vernadsky and a large number of quotes from his original works given in this article made him the inspirer and co-author of this work. We tried, in this article, to answer those few questions, a huge number of which Vernadsky formulated in his fundamental scientific and philosophical works. According to the law of fractal geometry, the issues discussed have multiplied several times, thereby indicating

directions in scientific research that will form a new paradigm, a new worldview.

"The great process of the collapse of the old and the creation of new understandings of the surrounding world is going on around us, whether we want and realize it or not; things that seemed to be completely strong and established for us are being undermined at the very foundation − the century-old foundations of scientific thinking are crumbling, the covers that were accepted by us for completed creations are demystified, and under old names, new, unexpected content is revealed to the surprised gaze of contemporaries... What has always seemed scientifically impossible, tomorrow may turn out to be scientifically necessary" [1]. Yesterday's tomorrow – today – is already here.

REFERENCES

1. *Vernadsky Vladimir Ivanovich. Materials for the Biography*. [Prometey. Historical and Biographical Almanakh. Ser. "Life of Outstanding People". Compiled by Aksenov G., Scientific editor. Mochalov I.I. Vol. 15]. Moscow, Molodaya gvardiya Publ., 1988, 352 p.
2. Vernadsky VI. *Chemical Structure of the Earth's Biosphere and Its Environment*. Moscow, Nauka Publ, 1965, 374 p.
3. Tarasova NP, Mustafin DI. V.I. Vernadsky and the Problems of Radioactivity. *Voprosy sovremennoy nauki i praktiki,* 2013, 3(47):38-50 (in Russ.).
4. Vernadsky VI. *Ocherki i rechi* [Essays and Speeches]. Issue 1:159 p.; issue 2:124 p. Petrograd, Nauchnoe khim.-tekhnich. izd-vo Publ, 1922, (in Russ.).
5. Proceedings of the 1-27th Russian Conferences on Cold Transmutation of Nuclei of Chemical Elements (RCCTNCE). Dagomys-Sochi-Moscow, RUDN, 1993-2022.
6. Proceedings of the 1-25th International Conferences on Condensed Matter Nuclear Science (Cold Fusion, ICCF).
7. Balakirev VF, Krymsky VV, Bolotov BV, Vasilieva NV, Vachaev AV, Ivanov NI, Kazbanov VI, Pavlova GA, Solin MI, Trofimov VI, Urutskoev LI. *Vzaimoprevrashcheniya khimicheskikh elementov* [Mutual Transformation of chemical Elements]. Ekaterinburg, Urals Branch of RAS Publ., 2003, 96 p.
8. Mishinsky GV, Kuznetsov VD, Penkov FM. Nizkoenergeticheskaya transmutatsiya atomnykh yader khimicheskikh elementov. Raspredelenie po elementam v produktakh transmutatsii. nukleosintez [Low energy transmutation of atomic nuclei of chemical elements. Element distribution in the products of low energy transmutation. Nucleosynthesis]. *Journal formiruyushchikhsya napravleniy nauki* (*JFNN*), 2017, 17-18(5):61-81 (in Russ).
9. Mishinsky GV, Kuznetsov VD, Starostin VI. Natural nucleosynthesis. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2022, 14(4):461-484. DOI: 10.17725/rensit.2022.14.461.
10. Fleishmann M, Pons S, Hawkins M. Electrochemically induced nuclear fusion of deuterium. *J. Electroanal. Chem.*, 1989, 261:301-308.
11. Karabut AB, Kucherov YaR, Savvatimova IB. Nuclear product ratio for glow discharge in deuterium. *Phys. Letters A*, 1992, 170:265-272.
12. Savvatimova IB, Karabut AB. The products of nuclear reactions recorded at the cathode after experiments in a glow discharge in deuterium. *Poverhnost'* [Surface Investigation: X-Ray, Synchrotron and Neutron Techniques], 1996, 1:63-75; 78-81 (in Russ.).
13. Savvatimova IB. Transmutation Effects in the Cathode Exposed Glow Discharge. Nuclear Phenomena Or Ion Irradiation Results? *Proc. 7th Int. Conf. on Cold Fusion* (ICCF),

Canada, 1998: 342-350; Reproducibility of Experiments in Glow Discharge and Processes Accompanying Deuterium ions Bombardment. *Proc. 8th ICCF,* Italy, 2000: 277-283.

14. Solin MI. Experimental facts of spontaneous appearance of condensate of soliton charges with the formation of nuclear fusion products in liquid zirconium. *Fizicheskaya mysl' Rossii* [Physical Idea in Russia], 2001, 1:43-5. (in Russ.).
15. Controlled Nucleosynthesis Breakthroughs in Experiment and Theory. Editors Adamenko SV, Selleri F, A. van der Merwe. Series: *Fundamental Theories in Physics,* Springer, 2007, v. 156, 780 p., http://www.springer.com/physics/elementary/book/978-1-4020-5873-8.
16. Adamenko SV. The concept of artificially initiated collapse of matter and the main results of the first stage of its experimental implementation. Preprint, 2004, Kiev (in Russ.), http://proton-21.com.ua/publ/Preprint_ru.pdf.
17. Urutskoev LI, Liksonov VI, Tsinoev VG. Observation of Transformation of Chemical Elements during Electric Discharge. *Annales de la Fondation Louis de Broglie* (*AFLB*), 2002, 27(4):701-726.
18. Kuznetsov VD, Mishinsky GV, Penkov FM, Arbuzov VI, Zhemenik VI. Low energy transmutation of atomic nuclei of chemical elements. *AFLB*, 2003, 28(2):173-214.
19. Krivitsky VA. *Paradoksy Transmutatsii i Razvitie Zemli* [Paradoxes of Transmutation and the Development of the Earth]. Moscow, NITs "Academica" Publ., 2016, 238 p.
20. Kladov AF. Cavitation destruction of matter (in Russ.); http://roslo.narod.ru/rao/rao1.htm.
21. Didyk AYu, Wiśniewski R and Wilczynska-Kitowska T. The carbon-based structures synthesized through nuclear reactions in helium at 1.1 kbar pressure under irradiation with braking γ-rays of 10 MeV threshold energy. *Euro. Phys. Lett.*, 2015, 109: P.22001-P.1-22001-P.6.
22. Didyk AYu, Wiśniewski R, Wilczyńska-Kitowska T, Mishinsky GV, Semin VA. Synthesis of chemical elements under irradiation by bremsstrahlung gamma-rays of palladium in condensed gases. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2019, 11(2):143-160. DOI: 10.17725/rensit.2019.11.143.
23. Wisniewski R, Mishinsky GV, Wilczynska-Kitowska T, Zukowska Z, Rostocki A. Graphite-like structures, synthesized from gaseous He under high pressure, by braking irradiation of maximum energy of 10 MeV – modeling of the process. *Acta Physica Polonica B, Proceedings Supplement*, 2020, 13(4).
24. Vysotskii VI, Kornilova AA. *Nuclear Fusion and Transmutation of Isotopes in Biological Systems*. Moscow, Mir Publ., 2003, 304 p.
25. Vysotskii VI, Kornilova AA. Transmutation of stable isotopes and deactivation of radioactive waste in growing biological systems. *Annals of Nuclear Energy*, 2013, 62:626–633.
26. Kornilova AA, Vysotskii VI. Synthesis and transmutation of stable and radioactive isotopes in biological systems. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2017, 9(1):52-64. DOI: 10.17725/rensit.2017.09.052.
27. Mishinsky GV. Resonant interference exchange interaction. *RENSIT: Radioelectronics. Nanosystems. Information technologies,* 2019, 11(3):261-278. DOI: 10.17725/rensit.2019.11.261.
28. Kuhn TS. *The Structure of scientific revolutions.* University of Chicago Press, 1962, 172 p.
29. Mishinsky GV. Towards a new paradigm. *RENSIT: Radioelectronics. Nanosystems. Information Technologies*, 2020, 12(4):529-544. DOI: 10.17725/rensit.2020.12.529.

30. Mishinsky GV. New Paradigm and Parametry. *RENSIT: Radioelectronics. Nanosystems. Information Technologies*, 2021, 13(4):509-520. DOI: 10.17725/rensit.2021.13.509.
31. Mishinsky GV. Magnetic fields and high-temperature superconductivity in excited liquids. Unknown particles. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2021, 13(3):303-318. DOI: 10.17725/rensit.2021.13.303.
32. Mishinsky GV. Atom in a strong magnetic field. Transformation of atoms to transatoms. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2017, 9(2):147-160. DOI: 10.17725/ rensit.2017.09.147
33. Mishinsky GV. Magnitnye polya transatomov. Spinovy-nuklidny-elektronny kondensat [Magnetic fields of transatoms. Spin-nuclide-electronic condensate]. *Journal formiruyushchikhsya napravleniy nauki* (*JFNN*), 2017, № 15-16 (5):6-25 (in Russ), http://www.unconv-science.org/.
34. Mishinsky GV. Spin electron condensate. Spin nuclide electron condensate. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2018, 10(3):411-424. DOI: 10.17725/ rensit.2018.10.411.
35. Mishinsky GV. Non-Coulomb nuclear reactions of transatoms. Stellar energy and nucleosynthesis. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2018, 10(1):35-52. DOI: 10.17725/ rensit.2018.10.035.
36. Volkov VV. *Nuclear Reactions of deep inelastic Transfers*. Moscow, Energoizdat Publ., 1982, 182 p.
37. Pavlov AN. Quantum principles of the development of the Earth – a new paradigm of geology. *Prinzipy razvitiya i istorizma v geologii i paleobiologii* [Principles of development and historicism in geology and paleobiology]. Novosibirsk, Nauka Publ., 1990, pp. 115-122 (in Russ.).
38. Mishinsky GV. Multinuclear reactions in condensed helium. *RENSIT: Radioelectronics. Nanosystems. Information Technologies,* 2017, 9(1):94-105. DOI: 10.17725/ rensit.2017.09.094.
39. Wiśniewski R, Mishinsky GV, Gulbekian GG, Wilczyńska-Kitowska T, Semin VA. Sintez khimicheskikh elementov i tverdotelnukh struktur pri obluchenii γ-kvantami kondensirovannykh gazov [Synthesis of chemical elements and solid-state structures under irradiation by γ-quanta in condensed gases]. *JFNN*, 2017, 17-18(5):6-15 (in Russ).
40. Pulletikurti S, Yadav M, Springsteen G. Prebiotic synthesis of α-amino acids and orotate from α-ketoacids potentiates transition to extant metabolic pathways. *Nature Chemistry,* 2022, 14(10):1142-1150. DOI: 10.1038/s41557-022-00999-w.
41. Mandelbrot BB. *The Fractal Geometry of Nature*. Henry Holt and Company, 1983, 468 p.
42. Mandelbrot BB. *Fractals and Chaos: The Mandelbrot Set and Beyond*. Springer Science & Business Media, 2004, 308 p.
43. Vernadsky VI. *Living Matter*. Moscow, Nauka Publ., 1978, 219 p.
44. Turchin VF. *The Phenomenon of Science. Cybernetic approach to human evolution*. New York, Columbia University Press, 1977, 368 p.
45. Vernadsky VI. *Selected Works*. Moscow, Nauka Publ., 1960, vol. 5, 140 p.
46. Mishinsky GV, Kuznetsov VD. Element distribution in the products of low energy transmutation. Nucleosynthesis. *AFLB,* 2008, 33(3-4):331-356.
47. Krivitsky VA, Mishinsky GV, Starostin VI. Planetary nucleosynthesis and ore formation. Bose-Einstein spin condensate of atomic electrons and atomic nuclei. *Smirnovsky sbornik-2019* [Smirnov collection-2019] pp. 246-265. Moscow, "MAKS Press" Publ., 2019 (in Russ.).

48. Mishinsky GV, Krivitsky VA, Starostin VI. Quantum geology. The feasibility of nucleosynthesis not only in stars, but also on planets in the process of their evolution. *Smirnovsky sbornik-2020*, pp. 96-136. Moscow, "MAKS Press" Publ., 2020 (in Russ.).
49. Mishinsky GV, Starostin VI. Quantum geology is a scientific discipline born of a new scientific revolution. Planetary nucleosynthesis and ore formation. *Smirnovsky sbornik-2021*, pp. 155-192. Moscow, "MAKS Press" Publ., 2021 (in Russ.).
50. Grachev AF. Osnovnue problemy sovremennoy tektoniki i geidinamiki Severnoy Evrazii [Main problems of modern tectonics and geodynamics of Northern Eurasia]. *Fizika Zemli,* 1996, 12:3-32.
51. Rampino MR, Caldeira K, Zhu Yu. A pulse of the Earth: A 27.5-Myr underlying cycle in coordinated geological events over the last 260 Myr. *Geoscience Frontiers,* 2021, 12:101245.
52. Barenbaum AA. *Galaktika. Solnechnaya sistema. Zemlya* [Galaxy. Solar System. Earth]. Moscow, GEOS Publ., 2002, 392 p.
53. Vernadsky VI. *Iz istorii idey. Izbrannye trudy po istorii nauki* [From the History of Ideas. Selected works on the history of science]. Moscow, Nauka Publ., 1981, 215 p.